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15 APPARATUS FOR FABRICATING LIQUID CRYSTAL PANEL

[Abstract]

PROBLEM TO BE SOLVED: To provide a liquid crystal panel production apparatus which is capable of uniformly heating the entire surface of glass substrates, acting 20 the pressurization of these glass substrates as a uniform distribution load and further rapidly cooling surface plates after a heating treatment.

SOLUTION: The device consists of the one stationary surface plate 1 which holds two sheets one set of the aligned and temporally fixed glass substrates and the moving surface plate 2 which faces this stationary surface plate 1, is capable of 25 varying the spacing from the surface plate 1 and is pressurized by a pressurizing

means. The stationary surface plate 1 is composed of a two-layered structure obtd. by embedding a cooling means 4 in an upper layer member 1a on the side nearer the glass substrates (a), (b), equipping the lower layer member 1b on the side distant therefrom with a heating means 5 and further providing the plate with

5 a separating mechanism 3 for disconnecting the contact states of the upper and lower members 1a, 1b. The moving surface plate 2 is composed of a hollow structure equipped with the heating means 5 and the pressurizing surface in contact with the glass substrates (a), (b) is composed of a member having flexibility.

[Claims]

[Claim 1] An apparatus for fabricating a liquid crystal display panel heating and pressing two glass substrates, which are in a state of facing each other with spacers interposed therebetween and being bonded, and hardening a sealing material formed of thermosetting resin and disposed between the two substrates, comprising: a stationary surface plate which holds one set of two aligned and temporarily fixed glass substrates; and a moving surface plate which faces the stationary surface plate, varies an interval between itself and the stationary surface plate and is pressed by a pressing device, wherein the stationary surface plate has a two-layered structure in which a cooling means is embedded in an upper layer member adjacent to the glass substrate, a heating means is mounted to a lower layer member distanced from the glass substrate, and a separating mechanism for disconnecting a contact state of the upper and lower layer members is further installed, and the moving surface plate has a hollow structure equipped with a heating means and its pressing surface coming in contact with the glass substrate is formed of a member having flexibility.

[Claim 2] The apparatus of claim 1, wherein the moving surface plate has within in a hollow portion, a reflecting plate provided with a heater.

[Claim 3] The apparatus of claim 1 or 2, wherein a flexible pressing member of the moving surface plate has a flexible film having a rate of heat expansion which is the same as that of a glass substrate.

[Title of the Invention]

## APPARATUS FOR FABRICATING LIQUID CRYSTAL PANEL

[Detailed Description of the Invention]

[Field of the Invention]

5       The present invention relates to an apparatus for fabricating a liquid crystal display panel and particularly, to a fabrication apparatus forming a liquid crystal panel securing a predetermined gap by heating and pressing the upper and lower glass substrates having therebetween a sealing material of thermosetting resin and accordingly hardening the sealing material.

10      [Description of the Prior Art]

In a liquid crystal display(LCD) panel, spacers of several micrometers are installed between two glass substrate each of which is coated with a transparent conductive electrode to maintain a predetermined interval between the glass substrates, and a liquid crystal is sealed in a divided inner space by a sealing 15 material. Thus, the two glass substrates can be bonded together by position alignment marks without being misaligned.

Spacers are dispersed on one of the two glass substrates constituting the LCD panel, a sealing material of thermosetting resin is installed inside of the other glass substrate (e.g. at a surface facing the one substrate), so that the upper and 20 lower glass substrates undergo the mark alignment and are bonded by a bonding device and simultaneously are temporarily fixed so as not to be separated. Then, as one pair of two glass substrates that have been bonded and temporarily fixed are heated and pressed, the sealing material is pressed to be as small as a particle size of the spacer formed at the gap between the upper and lower glass 25 substrate and is hardened.

The prior art apparatus for hardening a sealing material performs a bonding operation of the substrate in a state of covering at least one of the pair of two glass substrates with a flexible material, reducing pressure within a container receiving a panel, and evacuating the container from the outside. By such a 5 structure, the apparatus can apply uniform pressure to the substrate. The apparatus which presses (applies pressure to) the substrate with a flexible material has remarkably improved uniformity in pressure applying and reduces display caused unevenness due to a defective gap as compared to an apparatus using a surface plate having high stiffness.

10       Also, as a heating method, a method of disposing a heating device at upper and lower surface plates having a pair of two substrates therebetween so as to heat an entire surface of a panel has been proposed in JP 5-232420. According to this configuration, a high-speed heating nature and uniform heat nature have improved compared with a method of heating a panel side using a heater in a  
15      furnace

[Problem(s) to be solved by the Invention]

By forming one of surface plates of a flexible member, a defective gap between upper and lower substrates can be prevented to some extent, but misalignment of the upper and lower substrate in a horizontal direction or bending 20 of the substrate cannot be prevented. Particularly, if 2 sets of panels are arranged side by side within one container for the purpose of productivity improvement, a degree of the misalignment in a horizontal direction is increased.

Also, because heat is transmitted from an upper side to a lower side in an device in which a heating device is disposed at the upper and lower surface plates,  
25      bending is reduced but the misalignment of about several micrometers between

the upper and lower glass substrates cannot be prevented. Furthermore, as the location precision becomes strict with the improvement of liquid crystal performance, such misalignment of several micrometers between the substrate has becomes a nonpermissible value. Also, in the prior art structure, an 5 experimental result clearly showed that the degree of misalignment is increased when a pair of two glass substrates are not disposed at the center portion of the surface plate or when a plurality of glass substrates are disposed side by side at the surface plate, as compared to when the pair of glass substrates are disposed at the center portion of the surface plate. Based upon such result, it became clear 10 by the experiment that the misalignment occurs between the upper and lower substrates because a shearing force between a surface plate and a substrate and between the substrates is generated by the difference in coefficient of thermal expansion between the upper and lower surface plates and the difference in coefficient of friction between the surface plate and the substrate by locations of 15 the upper and lower surface plates, and a force is most likely to be released between the upper and lower substrates attached by a sealing material formed only at their edge portions. Also, if heat capacity of the upper and lower heating device for securing a uniform heat nature may be increased in the prior art apparatus, it has a problem that heating and a cooling rate are degraded. 20 Especially when the apparatus for mass-production is considered, the number of apparatuses proper to a tact time of line is prepared. Also, when a panel is set in the apparatus, at least its portion contacting with a substrate needs to be cooled at a certain temperature for some reason in process.

In order to solve the aforementioned problems of the prior art, an object of 25 the present invention is to provide an apparatus for fabricating a liquid crystal

display panel capable of uniformly heating an entire surface of a glass substrate, pressing the glass substrate with a uniform distribution load, and quickly cooling a surface plate after the heating process.

[Means for Solving the Problem]

5        In order to attain the aforementioned object, a technical object of an apparatus for fabricating a liquid crystal display panel in accordance with the present invention, which heats and presses two glass substrates, which are in a state of facing each other with spacers interposed therebetween and being bonded and hardens a sealing material formed of thermosetting resin and  
10      disposed between the two substrates, includes a stationary surface plate which holds one set of two aligned and temporarily fixed glass substrates and a moving surface plate which faces the stationary surface plate, varying an interval between itself and the stationary surface plate and pressed by a pressing device. Here, the stationary surface plate has a two-layered structure in which a cooling means is  
15      embedded in an upper layer member adjacent to the glass substrate, a heating means is mounted to a lower layer member distanced from the glass substrate, and a separating mechanism for disconnecting a contact state of the upper and lower layer members is further installed. The moving surface plate has a hollow structure equipped with a heating means and its pressing surface coming in  
20      contact with the glass substrate is formed of a member having flexibility.

As the stationary surface plate, a member having high stiffness and thermal conductivity, for example a metal plate or a high graphite plate, may be used. However, the member directly contacting with the glass substrate is limited to a member having a coefficient of thermal expansion which is almost the same  
25      as that of a glass substrate. The stationary surface plate having a two-layered

structure has a cooling means embedded in its upper layer member adjacent to the glass substrate. Because a water cooling method is good for the cooling means, a path for laying a cooling pipe is formed at the upper layer member. Also, a heating means is installed at the lower layer member of the stationary surface plate, which is distanced from the glass substrate, which allows uniform by heat conduction.

As for the moving surface plate, a flexible member with low stiffness is mounted at one side of a frame having a rectangular plane shape and an heat insulation function and a heating means is mounted in an hollow portion formed by the flexible member and the frame. By such structure, the moving surface plate indirectly heats the flexible member, reduces temperature distribution of the entire apparatus and improves the heat uniformity of the glass substrate. As the flexible member constituting the moving surface plate, a graphite plate having low stiffness or a film having a coefficient of thermal expansion which is almost the same as that of the glass substrate, for example, polytetrafluoroethylene (PTFE) sinking-in glass tissue, the polytetrafluoroethylene (PTFE) sinking-in glass tissue containing carbon, etc. may be used.

Also, because the heating means of the moving surface plate is an auxiliary heater, there is no need to control the temperatures of the upper and lower heaters identically like the conventional example and preferably, the temperature of the heating means may be set to be just similar to that of the heating means mounted at the stationary surface plate. Furthermore, as the heating means, a reflecting plate provided with a rubber heater with small heat capacity is desirable. Depending upon a method of raising a temperature of the heating means mounted to the stationary surface plate, heat may be reflected

from the heating means to the reflecting plate, thereby minimizing output of the rubber heat and accordingly reducing energy. As the reflecting plate, a metal mirror coating on which coating of an aluminum plate or gold, and silver is performed may be used.

5        Furthermore, as a separating mechanism which separates the lower layer member and the upper layer member of the stationary surface plate, a device using an eccentric cam or a device operated by a cylinder using oil pressure and pneumatic pressure may be used.

10      The moving surface plate has a hollow structure and has a pressing side made of a flexible member having stiffness lower than that of the stationary surface plate to creates a stiffness difference between the stationary surface plate and the pressing side of the moving surface plate. As the flexible member having low stiffness, of the moving surface plate is closely adhered to the glass substrate with a uniform distribution load, a uniform gap between the upper and lower glass substrate is formed. The stationary surface plate has a two-layered structure of upper and lower layer members. Here, a cooling means is installed at the upper layer member close to the glass substrate and a heating means is installed at the lower layer member distanced from the substrate, thereby allowing quick freezing and heating. The upper and lower layer members of the stationary surface plate having the two-layered structure may freely contact with and be separated from each other by a separating mechanism. After heating and pressing, the upper and lower layer members are separated and the upper layer member is cooled so as to improve cooling efficiency and so as not to affect the temperature distribution of a panel when the next panel is set and heat is applied thereto.

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25      [Embodiment of the Invention]

An embodiment of the present invention will now be described with reference to accompanying drawings. Figure 1 is a schematic view which illustrates an apparatus for fabricating a liquid crystal display (LCD) panel. In Figure 1, one set of two aligned and temporarily fixed glass substrates are 5 mounted in the apparatus for fabricating the LCD panel and are heated and pressed, so that the sealing material mounted between the glass substrates is pressed to form a predetermined gap therebetween and is hardened. In Figure 1, reference numeral 1 is a stationary surface plate having a two-layered structure of upper and lower layer members, 2 is a moving surface plate disposed above the 10 stationary surface plate 1 in a facing manner, and 3 is a separating mechanism vertically separating the upper and lower layer members 1a and 1b attached together and constituting the stationary surface plate 1 from each other.

One set of two glass substrates constituting the LCD panel are put on the stationary surface plate 1. The stationary surface plate 1 includes an upper layer member 1a and a lower layer member 1b that have a rectangular plane shape and are formed as a graphite plate having high stiffness. A cooling water pipe of a cooling means 4 is insertedly installed at the upper layer member 1a that comes in contact with the glass substrate, and a heater of the heating means 5 is insertedly disposed at the lower layer member 1b. The facing surfaces (bonding surfaces) of 15 the upper and lower layer members 1a and 1b are in contact with each other when the glass substrates are heated and pressed, so that heat of the heating means 5 insertedly disposed at the lower layer member 1b is transferred to the upper layer member 1a, thereby effectively heating the glass substrate.

Also, both the bonding surfaces of the upper and lower layer members 1a 20 and 1b are flat surfaces and are constructed such that their entire surfaces come

in contact with each other. A recessed portion is formed at the bonding (facing) surface of one of the upper and lower layer members 1a and 1b except its edge portion, and heat of the lower layer member 1b is transferred to the upper layer member 1a through an air layer of the recessed portion. If the recessed portion is 5 formed, the heat uniformity and flatness of the stationary surface plate 1 can be improved. However, even if contact between the upper and lower layer members 1a and 1b improves display flatness, contact resistance is large, and it is also difficult to maintain heat balance and to improve heat uniformity. Therefore, instead of raising the display flatness, a film having cushioning properties and 10 good thermal conductivity, for example, a graphite fiber film, is interposed between the upper layer member 1a and the lower layer member 1b. Also, in order to maintain a stable contact state between the upper and lower layer members 1a and 1b, springs 6 are installed at several portions of the upper and lower layer members 11a and 1b. As the graphite fiber film inserted between the upper and 15 lower layer members 1a and 1b is compressed by the operation of the spring 5, the gap between the upper and lower layer members 1a and 1b is filled, and the heat uniformity is obtained.

Moreover, a frame 7 surrounding one group of two glass substrates a and b loaded on the surface of the stationary surface plate 1 is disposed and fixed at 20 the peripheral of the surface of the upper layer member 1a of the stationary surface plate 1 which contacts with the glass substrate. The frame 7 has the same thickness as a thickness that the glass substrates a and b are combined, and an O ring 8 is installed outside of the frame 7. Thus, when the moving surface plate 2 to be mentioned later is lowered to come in contact with the glass substrate, a closed 25 space is formed by the stationary surface plate 1, the moving surface plate 2, and

the O ring 8, and the inner space can be evacuated through a path 9.

The moving surface plate 2 disposed above the stationary surface plate 1 has a pressing plate 2b formed of a flexible member at one side of a passage surface (lower surface) of rectangular frame 2a having an insulation function  
5 several times better than that of the stationary surface plate 1. As the pressing plate 2b, a sheet whose one side has flexibility with a coefficient of thermal expansion which is almost the same as that of the glass substrata, for example, polytetrafluoroethylene (PTFE) sinking-in glasscross is used. When static electricity becomes a problem, it is good to use the polytetrafluoroethylene (PTFE)  
10 sinking-in glasscross containing carbon. The attachment of the pressing plate 2b is started from an edge of the sheet constituting the pressing plate 2b along an outer side of the frame 2a, the started edge is pressed by a sheet fixing member 11, and the sheet fixing member 11 is fixed by a screw 12. The pressing plate 2b is fixed to be slacked to an extent that a center portion hangs down.

15 Moreover, a heating means 10 is disposed and received inside the moving surface plate 2, namely, above the pressing plate 2b inside the frame 2a. The performance which the moving surface plate 2 is asked for is plane heat uniformity and an upper and lower temperature relation with the stationary surface plate 1. Therefore, preferably, the heating means 10 which makes the generation of  
20 temperature unevenness difficult is installed. In another structure, as shown in Figure 2, a reflecting plate having a rubber heater with high plane-heat uniformity and small heat capacity is hung above the pressing plate and supported. The reflecting plate 10 to which the rubber heater is attached has a reflection plate 10b under the silicon rubber heater 10a. Thus, heat is reflected from the upper layer  
25 member 1b of the stationary surface plate 1 to the reflection plate 10b, which

contributes to minimizing output of the rubber heater 10a and saving energy. Also, as the reflection plate 10b, an aluminum plate or a flat plane having experienced metal mirror coating may be used.

The moving surface plate 2 having such a structure is hung to and  
5 supported by a support member 13, and as an object moving the supporter  
material 13 downwardly, the pressing plate 2b // the O ring of the stationary  
surface plate1//

The separating mechanism 3 for separating the upper and lower layer  
members 1a and 1b constituting the stationary surface plate 1 from each other  
10 uses an eccentric shaft 14. Two separating mechanisms are installed at both right  
and left sides of the stationary surface plate 1 at the same interval from the center  
in forward and backward direction and are simultaneously operated, to thereby lift  
up the upper layer member 1a and thus separate the upper layer member 1a from  
the lower layer member 1b (e.g., release their contact state). As for the separating  
15 mechanism 3, a housing 15 rotatably supports the eccentric shaft 14 with a  
bearing 16 therebetween, and another bearing 16' is installed at a front end side of  
the eccentric shaft 14, namely, at its portion supporting a lower surface of the  
upper layer member 1a. Also, another end side of the eccentric shaft 14 is  
connected to an output shaft of a rotary cylinder 17 by coupling 18, and the  
20 eccentric shaft 14 is rotated by the rotation of the rotary shaft 17. The separating  
mechanism 3 can lift up the upper layer member 1a as high as a dimension "L"  
with the bearing therebetween 16' by the rotation of the rotary cylinder 17, thereby  
separating the upper layer member 1a from the lower layer member 1b (releasing  
their contact state). A driving source rotating the eccentric shaft 14 of the  
25 separating mechanism 3 is not limited by a rotary cylinder (air operated actuator)

but it may be an electric motor. Moreover, at the time of the actuation of a separation mechanism 3 mentioned above, the upper and lower layer members 1a and 1b are supported with a guidance stanchion or the like so that a relative location relationship therebetween may not be shifted.

5       The operation of the aforementioned fabrication apparatus will now be described. In a state that the moving surface plate 2 is lifted up with respect to the stationary surface plate 1, one set of two aligned and temporarily-fixed glass substrates a and b are loaded on a surface of the upper layer member 1a of the stationary surface plate 1. Then, the moving surface plate 2 is lowered so that its  
10      pressing plate 2b contacts with the O ring 8, then, a closed space is formed by the pressing plate 2b, the O ring 8 and the upper layer member 1b, and the inside of the closed space is evacuated through a path 9 of the stationary surface plate 1. Thusly, the pressing plate 2b of the moving surface plate 2 is transformed along the glass substrate a and closely attached thereto, thereby pressing the glass  
15      substrates a and b. Then, if the heating means 5 of the stationary surface plate 1 and the heating means 10 of the moving surface plate 2 are operated, the upper layer member 1b of the stationary surface plate 1 is heated by heat conduction from its lower layer member 1b, the glass substrates a and b are heated by heat transfer, a sealing material between the glass substrates a and b is compressed to  
20      form a predetermined gap therebetween and is fixed. Here, although the glass substrates a and b, the stationary surface plate 1 and the pressing plate 2b of the moving surface plate 2 are expanded by such heating, misalignment can be prevented because the stationary surface plate 2 and the pressing plate 2b have coefficients of heat expansion which are almost the same as that of the glass  
25      substrate. If the heating means 10 of the moving surface plate 2 is a reflecting

plate with a heater, heat is reflected from the stationary surface plate 1 to the reflecting plate 10b to be used to heat the glass substrate a, which contributes to minimization of heater output.

After molding by the heating and pressing, the heating means 5 of the 5 stationary surface plate 1 and the heating means 10 of the moving surface plate 2 are turned OFF, the closed space is returned to the atmospheric pressure, the moving surface plate 2 is lifted up, and a mold good (laminated glass substrates) on the stationary surface plate 1 is taken out. Then, the cooling means 4 of the upper layer member 1a of the stationary surface plate 1 is operated to cool down 10 the stationary surface plate 1. If the cooling is made in a state that the upper layer member 1a having the cooling means 4 is in contact with the heated lower layer member 1b, it takes long time to cool it down to a predetermined temperature and heat loss is increased, which deteriorates cooling efficiency and degrades productivity. For this reason, the fabrication apparatus in accordance with the 15 present invention provides a separating mechanism that separates the two upper and lower layer members of the two-layered-structured stationary surface plate, so that the upper and lower layer members 1a and 1b are separated during the cooling operation after molding by heating and thus the upper layer member 1a can be cooled in a state that an influence of heat of the lower layer member 1b is 20 eliminated. Also, by such operation, a surface temperature of the upper layer member 1a on which the next glass substrate is to be loaded can be lowered speedily to a predetermined temperature or lower, and a variation of the temperature distribution on the substrate can be prevented when the following glass substrate is set and heated. Also, as the upper layer member 1a and the 25 lower layer member 1b contact with each other at the time of heating and the

upper layer member 1a has a cooling function, an operation which flexibly sets a temperature profile of the glass substrate becomes possible.

[Effect of the Invention]

The apparatus for fabricating an LCD device in accordance with the present invention has the following effects. According to the structure cited in claim 1, an entire surface of the glass substrate can be uniformly heated and simultaneously, the glass substrate can be pressed with a uniform distribution load. Also, after the heating process, a surface of a surface plate where the glass substrate is loaded can be quickly cooled down to a predetermined temperature or lower. Also, according to the structure cited in claim 2, heat is reflected to the reflecting plate from a lower side to be effectively used for the glass substrate when the glass substrate is heated by the upper and lower heating means. Thanks to such construction, a heater installed at the moving surface plate side may have a small heat capacity, so that an apparatus that can save energy can be provided. In addition, according to the structure cited in claim 3, misalignment by heat expansion in heating can be prevented.

[Description of Drawings]

Figure 1 is a partially cut-out front view which illustrates one embodiment of a fabrication apparatus in accordance with the present invention;

Figure 2 is an enlarged sectional view which illustrates a structure of the moving surface plate;

Figure 3 is a plan view which illustrates distribution of a separating mechanism for separating upper and lower layer members of the stationary surface plate; and

Figures 4A and 4B are views for explaining the operation of the separating

mechanism by the eccentric shaft, wherein Figure 4A depicts a state that the upper layer member is in contact with the lower layer member, and Figure 4B depicts a state that the upper layer member is moved upwardly by the separating mechanism.